United States Department of Agriculture

Forest Service

NORTHEASTERN FOREST EXPERIMENT STATION

New Haven, Conn.

# ANNUAL REPORT FOR FISCAL YEAR 1935

and

# INVESTIGATIVE PROGRAM FOR FISCAL YEAR 1936

July, 1935

NORTHEASTERN FOREST EXPERIMENT STATI
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NORTHEASTERN FOREST EXPERIMENT STATION

SIGNIFICANT ACCOMPLISHMENTS FOR 1934

The following are high lights from the work of last year:

Forest Planting

1. Dug-hole planting shown to be superior to other methods in survival, vigor of trees, and root development.

2. Development of a Success Index to evaluate results of young plantations on the basis of age, survival, and height.

3. Development of a set of nursery record forms for the accumulation of adequate data on origin of plantations, including not only source of seed but character and treatment of stock.

Production Costs for Northern White Pine Lumber:

4. Demonstration of increased cost of handling logs and trees of below 14" in diameter. Quality of product was not significantly affected by size of the trees.

5. Preparation of grading rules for northern white pine logs. These should provide a sound basis for sale of stumpage and should encourage the growing of high quality timber.

Management of Spruce Types:

6. Development of a mathematical basis for predicting growth of spruce and fir on cut-over lands, based on time since cutting, density, and composition of the stand.

7. Demonstration of the feasibility of removing overtopping hardwoods from dense stand of spruce and fir without significant damage to the conifers.

8. Drainage of spruce swamp of 200 acres on the Gale River Experimental Forest to improve conditions for growth.

Management of Northern Hardwoods:

9. Distribution of paper giving suggestions for weeding in northern hardwoods, based on experience in weeding experiments now under way at the Bartlett Experimental Forest.

Mensuration:

10. Completion of report on application of form class volume table methods, with most significant finding that form class methods can have little superiority over well constructed tables of the conventional sort based on diameter and height alone.

11. Preparation and distribution of new volume tables in cubic feet, board feet, International, and board feet, Scribner, for white ash, paper and yellow birch, sugar maple, and beech.

Protection from Fire:

12. Preparation of charts for estimation of duff moisture content from evaporation for preceding 24 hours, air temperature, and hours since last rainfall.

13. From 25 to 45 percent of trees injured but not killed outright may be expected to die during the first year after a forest fire in the oak types.

Forest Pathology:

14. Cross inoculations indicate that Nectria diseases of hardwoods have many hosts and may be spread from weed species such as moosewood and mountain maple to valuable species.

15. Large pruning wounds on white pine may lead to damage from the wood-rotting fungus Stereum sarguinolentum.

16. A new stem canker on Norway pine discovered in southern Connecticut.

Forest Entomology:

17. Balsam woolly aphid found to be widely distributed in New England and associated with widespread death of balsam during the past few years.

Forest Biology:

18. Grouse population in central New Hampshire is limited primarily by predators.

# ANNUAL REPORT AND INVESTIGATIVE PROGRAM

## July - 1935

## FOREWORD

The Northeastern Forest Experiment Station, established in 1923, is one of 11 regional stations maintained by the Forest Service, United States Department of Agriculture. The territory served by the Northeastern Station includes all of New England and New York. Headquarters are maintained at New Haven, Connecticut, in cooperation with Yale University.

The Northeastern region includes almost 40 million acres of forest, comprising considerably more than half of the total land area. A wide variety of forest types and economic conditions is represented in these forests. On the one hand there are over 11 million acres of farm woodlands or 28 percent of the total forest area, while on the other an almost unbroken wilderness of about 10 million acres still remains in northern Maine. The region includes the most densely populated industrial section of the country and this places an unusually heavy demand on the forest for recreational as well as industrial use.

Ever since Colonial times, the forests of the Northeast have been an important source of livelihood to the people of the region, but forest fires, insect pests, diseases, and unrestricted cutting in successive waves of closer utilization fostered by proximity to the industrial markets, have so depleted the forests that their full potentialities as a source of stable employment, industrial development, and community welfare are not being realized.

The Northeastern Forest Experiment Station was established to study the various problems involved in the management, rehabilitation, and protection of these forests in order that they may more effectively supply raw material for industry, and at the same time support a larger and more varied wild-life population and adequately serve the recreational needs of the people.

## ADVISORY COUNCIL

The experiment station is assisted in the formulation of its program by an advisory council organized by the Secretary of Agriculture. This council also serves to coordinate and stimulate forest research by all agencies in the region. Its membership includes state foresters, directors of agricultural experiment stations, heads of forest schools, educators, timberland owners, lumbermen, pulp and paper manufacturers, and other influential citizens interested in the development of the forest resources of the Northeast.

The Council met twice during the year 1934. The first meeting, held at New Haven, Connecticut, on February 21, 1934, was included in last year's annual report. The interrelation of wild-life and forest management was the principal topic for discussion at this meeting and representatives from the various state game departments were invited to

be present. Although the attendance was small on account of a blizzard, the meeting served to emphasize the need for a comprehensive and thoroughgoing program of wild-life research, oriented from the point of view of forest management.

For the second meeting, September 8 and 9, the Council was the guest of the New York State College of Forestry at the Pack Demonstration Forest, Warrensburg, New York. The principal topics for discussion were "The Part of Forestry in the Land Use Planning for the Northeast" presented by R. M. Evans, Regional Forester, U. S. Forest Service, and "Research Which May Assist in the Application of the Conservation Articles in the Codes of the Forest Industries" presented by A. B. Recknagel, Secretary of the Empire State Forest Products Association. At the evening session, Dean Spring explained to the Council the policy of the New York State College of Forestry in respect to demonstration and research forests and then Professors Heiberg and Foster described the Pack Forest and its organization and showed how it was being used for research, instruction, and demonstration. Field trips over the forest the next day gave the Council an opportunity to discuss a number of experimental projects in detail on the ground.

## COOPERATION

The Northeastern Station is not receiving direct financial cooperation from any outside source at the present time. The status of the activities of the Bureaus of Plant Industry, Entomology, and Biological Survey in cooperation with this Station are discussed along with investigation of the Forest Service in a later section.

The Bureau of Entomology and Plant Quarantine is now planning to concentrate a larger part of its forest insect work in the Northeast at New Haven. The work on forest pests formerly carried on at the Gipsy Moth Laboratory at Melrose Highlands, Massachusetts, will be moved to the Northeastern Station this year, but shade tree insect investigations will be handled elsewhere.

Entirely apart from its program of work, the Northeastern Station is cooperating further with the Bureau of Entomology and Plant Quarantine by providing office space at New Haven to three men engaged in Corn Borer Investigations in New England. This arrangement is under informal agreement, subject to termination on thirty days' notice.

The Biological Survey has made substantial progress in the physical development of the Pillsbury State Forest in New Hampshire for experimental purposes in cooperation with the State Forestry Department. In order to promote closer cooperation with the Experiment Station staff and to facilitate contacts with other agencies in the region, consideration has been given to the possibility of employing an assistant to maintain residence on the Pillsbury Forest so that the principal representative of the Biological Survey in this region may make his headquarters at the Northeastern Station.

Active cooperation is maintained with the National Forest organization both in the field and in Washington. During the winter

Westveld assisted the White Mountain Forest staff in preparing a plan and selecting locations for sample plot studies to follow up the results of girdling operations by the Civilian Conservation Corps. The Station has also cooperated with the Regional Forester in preparing specifications for the purchase of planting stock. Fuel for two C.C.C. camps on the White Mountain Forest has been obtained from our experimental areas in connection with research projects and the Forest has continued to allot a generous portion of the time of these two camps for the development of these experimental tracts. Of special interest in this connection is the excellent assistance for work on permanent sample plots which was afforded by assigning to our work a number of forest school students who had enrolled in the camps for the summer. In order to develop a more intimate understanding of objectives and programs, it is planned to hold annual meetings of the Experiment Station staff with a representative of the National Forests in the Northeast end of the regional office.

Cooperation in the collection of phenological data was obtained from a larger number of persons last year than ever before. This was largely the result of enlisting, through the state foresters, the aid of interested individuals in a number of the C.C.C. camps.

The Massachusetts State College cooperated actively with the Station last fall in the study of costs of production of white pine lumber which was undertaken jointly by the Experiment Station and the Forest Products Laboratory. The College undertook to obtain data on logging and milling costs in connection with the selective cutting of a tract of pine on its Mount Toby demonstration forest. These data have been turned over to the Forest Service for analysis so that the results may be incorporated with those obtained from the five other jobs studied.

In connection with this project, an advisory committee was invited to discuss the method of cutting and marking policy to be adopted on two of the tracts where partial cuttings were to be made. Those who cooperated in this helpful conference were:

| | |
|---|---|
| K. E. Barraclough | Extension Forester, New Hampshire |
| A. C. Cline | Harvard Forest |
| R. C. Hawley | Yale School of Forestry |
| Svend Heiberg | New York State College of Forestry |
| R. P. Holdsworth | Massachusetts State College |
| J. H. Rich | Massachusetts State College |

## EXPERIMENTAL FORESTS

In developing an adequate program of research in the region, the Northeastern Forest Experiment Station aims to concentrate its work to a large extent on experimental forests, set aside especially for the purpose. Experience has shown that this is a wise policy not only because it safeguards long-time experiments from outside interference, but also because it permits accumulation of more detailed

information concerning the meteorological and ecological conditions under which the experiments are conducted and also because it leads to greater efficiency in handling the work, and better correlation of different lines of investigation in the same locality.

The Northeastern Station now has four experimental forests, and eventually should have at least four more to adequately cover the principal forest types of the region.

The Gale River Experimental Forest, about 1,365 acres in area, is part of the White Mountain National Forest near Bethlehem, New Hampshire, and is being developed primarily for studies of the management of spruce. Work on this forest is supplemented by centers of work in the Waterville Valley and along the Cherry Mountain Road.

The Bartlett Experimental Forest, of about 3,500 acres, part of the White Mountain National Forest at Bartlett, New Hampshire, will serve primarily for studies of the management of northern hardwoods.

The Chenango Experimental Forest, an area of 534 acres, belonging to New York State, near Norwich, New York, made available under cooperative agreement by the New York State Conservation Department, is largely open abandoned farm land and will be used for experiments in reforestation.

The Finch Pruyn Experimental Forest, situated in the Adirondack Mountains, near Newcomb, New York, is a tract of 623 acres deeded by Finch Pruyn and Company to Cornell University for research purposes, and made available to the Experiment Station under cooperative agreement. This area is suited for studies of the spruce and northern hardwood forests as they occur in the Adirondacks. It will serve as a center for other work in the vicinity.

Negotiations are pending with Williams College for the use of a tract of about 1,600 acres in the northwest corner of Massachusetts, which will serve for study of the problems of rehabilitation of the lands in central New England formerly devoted to agriculture and now in various stages of regrowth. When this tract becomes available, it will also serve admirably for studies of the possibilities of developing wild-life management in connection with the improvement of the forest for timber production.

Consideration is also being given to the acquisition of an experimental forest in the white pine region of southwestern Maine. A special act of the Maine legislature has opened the way for purchase of a portion of the Bates College Forest which has been under technical management for twelve years and on which records of operations and growth for this period are available. Adjacent lots other than those now owned by Bates College should also be acquired in order to block-up a solid tract of from 2,000 to 3,000 acres.

Should a National Forest purchase unit be established in southeastern Maine, consideration should also be given to the selection of an experimental forest in that section of the spruce region, which would supplement in a desirable way the experimental areas already established.

The Northeastern Station should also have an experimental area in the oak region of southern New England and perhaps eventually another will be needed for the special conditions which obtain on Cape Cod and Long Island.

Construction of improvements on the experimental forests already established has progressed rapidly as a result of unemployment relief programs of the past three years. On the Gale River Experimental Forest a system of truck trails has been completed so that no portion of the area is more than a quarter of a mile from a road. Old log roads have been brushed out and some work done on improving their drainage and surface. Fire lines have been constructed along the eastern boundaries and along the Trudeau road to protect the new plantations. Blister rust control work has also been undertaken to protect the eastern end of the forest for the growth of white pine.

An office-laboratory building, a dwelling, and three-car garage, all with water and electric power connections, have been erected at Gale River. To complete the facilities which will be required for best handling the work at this forest, a year-long dwelling for a resident superintendent, and additional storage space for trucks and other heavy equipment should be provided.

On the Bartlett Experimental Forest, five miles of truck trail have been constructed. The desired road system will be completed this year by the construction of an additional two miles of truck trails most of which will be in steep, rocky country. Several miles of old log roads have also been brushed out to facilitate their use and foot trails have been constructed through the higher portions of the forest. Blister rust control work surrounding the northern end of the forest has been completed.

Buildings similar to those constructed at Gale River have also been erected at Bartlett supplementing the old ranger station there. It is planned to complete the headquarters facilities at Bartlett by erection of another year-long residence and a greenhouse.

At the Chenango Experimental Forest a temporary dwelling and two-car garage were erected last year. An office-laboratory and additional storage shed are contemplated for the future. It is also planned to extend a power line to the building site and to construct some truck trails to facilitate access to all parts of the tract.

A temporary dwelling and two-car garage have also been erected on the Finch Pruyn Experimental Forest, and it is proposed to supplement these eventually with an office and laboratory building. Construction of truck trails to afford access to portions of the tract on either side of the public highway is also contemplated for the coming year.

## Forest Economics

For a number of years it has been apparent that progress toward widespread application of forestry principles in the management of forest lands in the Northeast has been impeded more by economic difficulties than by lack of technical knowledge of silvicultural practices.

### Forest Survey

There is urgent need for a comprehensive survey of the forest resources of the region to determine for each state and for smaller economic units the quantity, quality, and location of existing supplies, the present and potential growth, the rate of depletion and consumption, and trends of utilization of forest products. Such information, when correlated with results of the national forest survey in other sections of the country is essential for determining sustained yield capacities and for long range planning aimed at industrial and community stability.

Interest in a regional forest survey is widespread. It is frequently expressed in letters from forest industries and others and has been stimulated by recent activities of the state planning boards. The forestry departments in New York and Connecticut have both made proposals for statewide surveys of forest resources to be financed by work relief or PWA funds. It is highly desirable that such local projects be conducted in a comparable manner and that the survey should be pushed through on a regional rather than piece-meal basis when once started. It is hoped that a survey organization may be set up for this purpose at the Northeastern Forest Experiment Station during the summer of 1936.

### Cooperative Forest Management and Wood Utilization

Another group of problems arises out of the past history of forest industries in the region. Successive waves of unrestricted cutting, prompted largely by heavy demands from adjacent industrial populations, have depleted the available growing stock to a point where many industries have been forced to move to other regions and those remaining find little timber of attractive quality.

In this situation small woodland owners, especially the farmers, have little opportunity to dispose of their timber except in lump sums to portable-mill operators. Returns to woodland owners are relatively low and realized only once in several decades. The portable mills which convert so much of the timer in the region are notoriously wasteful and inefficient. Many of the typical small permanent mills are entirely obsolete and utterly uneconomical in arrangement or location. Rarely is lumber properly cared for when cut. Finally marketing is generally on a haphazard and uncertain basis with the buyer usually dictating the terms and the mill men barely making a living wage.

Economic studies are needed to establish a basis for the amelioration of conditions in each stage of the process to the end that the margin for stumpage may be kept at a level which will be an incentive to forest

management and that returns from woodland may be stable and continuous. If this can be done, the woodlands of the region will begin to yield their full potentialities in employment and community welfare to the mutual benefit of the industries and the landowners.

A new appropriation will permit the Northeastern Station to initiate studies in this field during the summer of 1935. These studies will be aimed at aiding the farmers, stabilizing communities, and improving the channels of trade in the forest products industries by correlation of the forest growing, manufacturing, and marketing enterprises in the woodlot sections.

Primary attention will be given to the possibilities of cooperative management of the woodland in typical natural units, with the idea that selective cutting for special requirements under qualified forestry guidance will permit a regular and dependable source of income and, at the same time, build up growing stocks to a more satisfactory level. Surveys will be needed to ascertain the character, amount, and location of existing stands and to determine the amount which may be cut annually on a sustained yield basis. Studies in methods of cutting and transportation will also be needed to work out the most economical ways of accumulating at a central plant in each unit the material cut selectively in widely scattered lots.

In respect to the manufacturing enterprise, experiments should be conducted in mills especially designed to handle economically the wide variety of generally low grade or poorly formed timber now available from the woodlots of the region. It is anticipated that construction of these plants may be financed by federal loans through the Rural Rehabilitation Corporation in each state.

The result of these studies should not be so much in the nature of an increase in production facilities as in supplanting or replacement of the irresponsible, itinerant, and inefficient portable mills by strategically located and efficiently designed permanent community mills.

In the marketing it should be possible to bring together desired quantities of certain species or sizes and provide steady outlets for a variety of products which cannot be reached by the individual timberland owner nor yet by the portable mill operator. The central agency might also serve to handle on a cooperative or profit sharing basis preservative treatment of fence posts, or other products, kiln drying, etc.

Development of a project of this sort will first be undertaken at Cooperstown, New York, where much local interest has already been aroused and where much of the preliminary work has already been accomplished independently. Work will be extended to units representing other forest types and economic conditions after the Cooperstown project is well on its feet.

Costs of Production

Another approach to the economic aspects of forest management in the Northeast is through analysis of the costs of producing lumber and

other products from trees of different sizes and studying the effect of selective or partial cuttings upon operating costs. Information of this sort would be of great help in the successful application of rules of forest practice such as were proposed under the codes of the forest industries. As a general principle, conservation of the forests will be promoted by selective or partial cutting rather than indiscriminate clear cutting. If exact knowledge of costs were available, selective cutting may perhaps prove also to be more profitable than clear cutting since experience has shown that under almost any condition costs of handling small trees are higher than for large trees. Furthermore, exact knowledge of costs should serve to discourage the cutting of immature second growth and demonstrate operating advantages in building up and maintaining growing stocks composed of trees of large size.

Production cost studies in the white pine region were undertaken in cooperation with the Forest Products Laboratory during the fall of 1934, and plans have been made for extending this work to pulpwood production and hardwood timber during the 1935-1936 season if funds become available. These studies also provide an opportunity for the formulation and testing of log grading rules which should aid in standardizing the buying and selling of timber and encourage the production of logs of high quality.

## Forest Management

### Forest Planting

A survey of forest planting in the Northeast completed in 1933 served to crystallize our program of planting investigations for the immediate future into four main lines. Primary attention is being devoted to studies of methods of planting, aimed at increasing the success and reducing the cost of forest planting. Experiments to determine the effect of depth and method of planting on survival, vigor, and root development have been initiated. These experiments show a very definite superiority in trees planted in dug holes with roots spread as compared to those set in slits without cultivation. Although increased initial costs for dug-hole planting are justified by better survival and growth, efforts should be made to develop an inexpensive approximation of this planting method. Planting in furrows cultivated by the Syracuse forestry plow offers one possibility along this line.

As a corrollary of our plantation survey, an alinement chart has been worked out which combines age, height, and percentage of survival into a single success index, which should prove useful as a means of evaluating results in young plantings.

The second major line of experimentation is concerned with the establishment of mixed plantations. Our survey confirmed the growing conviction of foresters that mixed plantations are preferable in many ways to pure stands of a single species. But the scarcity of good mixed plantings emphasized the need for developing more satisfactory methods of establishment.

Experimental plantings have been initiated on the Chenango Forest to test three different ideas for mixtures of hardwoods and conifers. One of these involves strips of varying width of white and red pines alternating with several desirable hardwoods. Another aims to establish the various species in blocks of about 1/10 acre with the individual trees in each block closely spaced in groups of various sizes. The third provides a skeleton planting of widely spaced white pine to be filled in with trainers or companion trees of other species by various methods after the pine is well established. In all of these experiments the possibility of obtaining proper competition and desirable canopy conditions by delaying the planting of hardwoods until a few years after planting of the pines is being recognized.

Development of satisfactory technique for the successful reforestation of areas presenting special difficulties because of poor drainage or heavy competition constitutes a third objective of the current program. On submarginal farm lands where reforestation is being undertaken, the most productive areas often present the most difficult problem. Where the drainage is good, successful planting is likely to be impeded by severe competition from dense herbaceous growth. Under such conditions best results with conifers will be obtained by the use of large, well developed transplant stock, preferably four years of age. Where drainage is poor, the problem requires much further study. Results with various species are being studied in relation to the indicator significance of the grasses, sedges, and other vegetation which occurs on such areas.

Finally questions relating to the source of seed for forest planting are being given attention from two angles. The first of these consists of testing the adaptability of promising strains of desirable species by field plantings of stock of known origin. Eight such plantings of a straight-boled, rapid growing, and prolific seed producing strain of Scotch pine have been established in the region in cooperation with the New York Conservation Department and other agencies. A series of plantings of Balkan white pine (P. peuce) said to be resistant to the blister rust is also under observation. As far as practicable local seed collections are being used for the production of stock for all of our planting experiments.

The second contribution to problems of source of seed has been an effort to develop and sponsor uniform adoption of a complete and simple system of nursery records which will permit automatic accumulation of adequate data on the origin of plantations throughout the region. A set of cross referenced forms covering seed, seedbeds, transplant beds, and plantings has been submitted to the state forestry departments for trial this year.

The feasibility of poisoning to eliminate undesirable woody growth from areas to be planted or to release young plantations from suppression is another problem which has demanded attention in connection with our planting experiments. Poisoning holds the possibility of being superior to cutting if it will prevent sprouting as well as kill the original growth. Some experiments in the use of sodium arsenite for this purpose have been carried out elsewhere, and Cope, in New York, has devised a special tool for injecting the poison.

Experiments in the poisoning of popple at the Gale River Experimental Forest in the late summer of 1933 were successful in eliminating the original growth but did not prevent the production of a new crop of root suckers. Sodium arsenite has also been used at Gale River for the elimination of alder thickets. In these experiments the poison was applied both to the original growth and to stumps on areas where the alders had been cut with an axe. Sprouting in the first year after treating was very materially reduced by the latter method of treatment. In this work the poison was injected from an oil can into hacks made with a light axe.

Poisoning of wild apple, hawthorn, cherry, and popple with sodium arsenite and calcium chlorate is being studied on the Chenango Experimental Forest. Neither of these chemicals was fully effective when applied in mid-winter. The chlorate failed to kill the original growth and sprouting was unchecked by the arsenite. More comprehensive tests using these two chemicals in varying concentrations at six weeks intervals throughout the season are now in progress.

Management of Spruce Types

Building on the results of previous work, one of the major objectives in this project is now the development of management practices which will increase or maintain the proportion of softwoods in the mixed forests of northern New England and New York and which will obtain the maximum net annual sustained yield in timber of most desirable size. Evidence in this country as well as experience in Europe gives strong indications that best results will be obtained under most conditions by growing the timber to relatively large size, and going over the ground with selective cuttings in cycles of not more than 30 years. Maintaining the large growing stock required by this policy permits operations to be confined almost entirely to the larger tree sizes which can be most economically handled, and concentrates on merchantable stems a large portion of the total annual growth which the land is capable of producing rather than dissipating this growth on a large number of saplings or weeds.

It is believed that as the accessible virgin timber in the West approaches exhaustion and as the pressure to liquidate stumpage in that region may be lifted, there will be an opportunity to revive a considerable volume of lumber production in the Northeast. Forests which have been managed under long rotations and in which large growing stocks have been maintained as suggested will then be in a very advantageous position.

Furthermore, it seems likely that it will be desirable to integrate the production of saw logs with the production of pulpwood and that this policy may be an important factor in supplying pulpwood at a cost which will permit Northeastern pulp mills to compete successfully with production from Canada, Europe, or other sections of the United States.

For these reasons a portion of the Gale River Experimental Forest has been designated for the production of spruce sawtimber and experimental work has been initiated which will contribute toward this objective. A series of thinning plots established in 1932 in a stand of

spruce and fir about 55 years old will serve to demonstrate the feasibility of cultural operations yielding pulpwood in commercial quantities and to ascertain how much such a stand may safely be opened up and how much the growth on the residual stems is stimulated.

Another series of plots on Mount Deception will contribute information on the problems of selective cutting and reproduction under the exceptionally difficult conditions presented by a pure stand of spruce about 100 years of age.

On two sawtimber compartments on the Gale River Forest, with stand now about 55 years old, selected spruce crop trees, mostly from 4 to 6 inches in size, have been pruned for the improvement of quality of the butt logs. In these compartments, more than 400 cords of hardwood including poplar, have been cut to release the softwoods from overhead competition. This operation demonstrated the feasibility of removing a scattered overstory without significant damage to the coniferous stand and without serious handicap to the operator. The next operation will consist in cutting of balsam fir, much of which is already of merchantable size, for pulp. Removal of the balsam will serve in the nature of a thinning and will utilize this species before any considerable losses from decay and breakage set in.

Cutting of hardwoods for fuel and peg-wood in other sections of the forest has also served to improve conditions for the growth of an understory of spruce and fir.

Drainage of a spruce swamp about 200 acres in extent affords opportunity to study the effect of drainage upon tree growth as well as fluctuations of the water level and other ecological changes in the swamp.

Results of all these operations are being studied by the measurement of growth on permanent sample plots.

New data on the management of mixed stands of spruce, fir, and hardwoods are being obtained from a series of 10 plots of 5 acres each which are included in the Mount Deception timber sale area. Since these plots were established in 1930, growth data for four years prior to cutting as well as meteorological records within the stand, have been obtained. These plots illustrate the differences between the sugar maple-beech-red spruce type, where it is difficult to maintain the softwood element, and the red spruce-yellow birch type, where the prevalence of advance reproduction of softwood species insures an adequate representation in the new crop. These permanent sample plot experiments should be supplemented by extensive study of spruce lands cut under different systems in the past.

Studies of girdling practices for the stimulation of growth of spruce are being continued and the work of previous years proved of great help in organizing and guiding the cultural program of the C.C.C. on the White Mountain National Forest.

Studies of the growth of spruce and fir on cut-over lands are nearing completion. A large number of the 400 temporary plots first tallied in 1923, 1924, and 1925, have been remeasured during the past

three years. Growth on cut-over lands in the spruce region is affected by so many variable factors that expressing prospective yields in tabular form or in any simple formula is extremely difficult. Yet it is important in planning for sustained yield management to have a sound criterion for estimating future production of cut-over areas. Statistical analysis of the data has resulted in a mathematical expression of the volume of spruce and fir on cut-over lands as a function of time since cutting, density as indicated by the relation between number of trees per acre and their average diameter, and composition, as indicated by proportion of the total basal area represented by spruce and fir. Separate equations have been worked out for the spruce-flat type and for the spruce-hardwood type. A report on this work should be ready during the coming year.

When available funds permit, a similar study should be undertaken to determine growth of spruce and fir on old burns and to evaluate the factors influencing the occurrence and growth of these species on such areas.

Management of Northern Hardwoods

One of the major problems in the management of northern hardwood centers around the extent to which selective or partial cutting may be substituted for the clear cutting now in general practice.

White ash, basswood, and black cherry, the most valuable of the northern hardwoods, are all intolerant and will develop well only with full overhead light. Moreover, desirable form in any of the hardwoods can be developed only by close competition from the side such as is produced in even aged stands. When these facts are considered in relation to the general abundance of advance reproduction of commercial species and the inferior quality of much of the residual hardwood forest of the region, it is apparent that clear cutting will often be the most desirable practice.

But the development and conservation of a large growing stock through selective logging, in order to obtain maximum yields and to concentrate the cut in the most profitable size classes is as desirable an objective with hardwoods as it is for softwoods. Furthermore, partial cuttings present much less of a fire hazard than clear cuttings, are seldom incompatible with recreational use of the forest, and probably are most effective in conserving watershed values. It is believed that the benefits of partial cutting may be attained without sacrifice of quality of the new growth by applying the group selection principle in cutting.

Experiments which will compare clear cutting with selective operations on a relatively short cutting cycle should, therefore, be of increasing value and interest. A series of plots which will permit five acres to be treated selectively and five acres to be clear cut each year for six consecutive years were established on the Bartlett Experimental Forest in 1933. The material cut from these plots up to the present has all been used as fuel.

Changes in meteorological conditions following partial cutting and the susceptibility of residual trees, especially of yellow birch, to deterioration in the tops or death as a result of such changes, are being studied on another series of plots established in 1932. The stand left after thinning on these plots has remained in vigorous condition and it is believed that decadence of hardwoods after cutting will not be serious unless the trees are left quite isolated.

Another important problem in the management of northern hardwoods is the treatment of young stands arising on cut-over areas. In such stands the more desirable species are often in the minority and are subject to suppression by the less valuable species and weeds. Weeding offers promise of improving the composition of these new stands and of stimulating the growth of the more desirable elements.

On the Bartlett Experimental Forest a series of 17 plots have been established to study the weeding problem in areas cut for fuelwood 4 to 10 years previously. Some of the points which these plots should clarify are period after logging when weeding will be most effective; amount of freedom desirable for crop trees; best method of accomplishing the weeding; effect of treatment on composition and growth of the stand.

Based on experience gained in treating these plots and adjacent areas, a paper giving suggestions for weeding in northern hardwoods has been distributed widely to foresters in the region. This paper shows that even under the unfavorable conditions prevailing at Bartlett, there will generally be found from 200 to 250 stems per acre of valuable species which may be benefited by weeding. It warns against weeding too heavily, a common tendency which increases the cost of the work and leads to the development of heavy branches and undesirable stem form in the crop trees.

In connection with the cutting of fuelwood on the Bartlett Experimental Forest, tests have been made of the Wolf portable power driven chain saw for felling and bucking. Experiments in the use of portable steel chutes for transporting wood to landings in hilly country have also been conducted. It is believed that a large field of useful work in the development of new equipment and methods and in modifying established woods practices could be opened up if funds were available for the purpose.

Mensuration

Initial effort on the northern hardwood growth project was directed at the preparation of volume tables. Tables of merchantable content in cubic feet and board feet by International (1/4" kerf) and Scribner rules are now available for sugar maple, paper and yellow birch, beech, and white ash. In addition, tables showing the total cubic content of trees below merchantable size have been prepared. To complete the series of volume tables needed for northern hardwoods, data on cubic foot contents of tops and branches of merchantable trees will be worked up to supplement the merchantable cubic foot tables, and finally, tables showing volume in ties and dimension stock bolts will also be prepared.

Detailed data have been obtained on variations in solid content of stacked cordwood. These show the effect of species, size of tree, size of sticks, length of sticks, and variation in piling, and will permit the determination of cordwood volumes from the cubic foot tables.

The merchantable tables were prepared from a mathematical formula expressing the taper of each species as a function of diameter breast high and height above ground. By this method the content of the first log in a tree of a given diameter is the same no matter what the height of the tree may be and the merchantable content of a two-log tree is the same as the volume of the first two logs of a taller tree of the same diameter. Although some difficulties arose in applying this principle to the data available for short trees, appropriate adjustments have been made, and the final tables should stand the test of time.

Over 100 plots have been established for the study of yield. These have been located in typical well-stocked, even-aged stands of various ages. These yield plots are to be supplemented by records covering 30 years on other permanent plots in the region and by analysis of stand conditions on the Bartlett Experimental Forest and elsewhere. In developing a method of predicting growth in the complex, many-aged stands characteristic of the northern hardwood forests, it is hoped that the stand table can be broken down into several age groups, each of which will constitute a segment or fraction of a normal, even-aged stand, and that by integrating the growth of these segments as determined from normal yield tables, an accurate picture of the development of the entire stand may be obtained.

A report on the application of form class volume table methods to spruce and fir was completed and submitted for publication during 1934. This report analyzes the interrelations of form quotient, bark thickness, and butt swell with various factors such as diameter, height, and crown length of the trees, and age density and site index of the stands. Since so large a proportion of the variation which can be accounted for in both form quotient and reduction of breast high diameter for bark thickness and butt swell is associated with diameter and height, it is concluded that in actual use form class volume tables can have little superiority over well constructed tables of conventional form, which give full recognition to variations due to diameter and height.

## Protection of Forests from Fire

Major effort in this field during the past two years has been directed toward studies of the ecological effects of forest fires and the damage done to standing timber. This work has been divided into two lines; namely, study of the basal wounding of trees by fire, and the relationship between bark character and heat resistance of the trees.

On the Bartlett Experimental Forest an area of twelve acres has been set aside for experimental burning. A light fire on this area in 1934 provided data on basal wounding to supplement records obtained on other recently burned areas in New York. This area will also serve for study of the effect of fire on reproduction, surface, vegetation, litter, and soil. Burning conditions in uncut timber in the White Mountains

are seldom severe, and it is planned to lay out and have an experimental burn on another area in Connecticut where conditions become more acute.

It has been found that in the oak type from 25 to 45 percent of trees wounded but not killed outright by fire are likely to die during the year following injury.

Laboratory studies of bark characteristics have been undertaken with beech, chestnut, oak, sugar maple, eastern hemlock, balsam fir, and pitch pine. Bark moisture content has been found to range from 40 to 60 percent as a general rule, beech and balsam fir bark containing a larger proportion of water at all seasons of the year than the other species investigated. Bark moisture content varies only slightly throughout the year.

The fire-weather charts prepared by the Station are proving of value in a number of states. These charts permit estimation of duff moisture content in the open from relative humidity, air temperature, and number of hours since rainfall. Since evaporation is more closely related to fuel moisture than any other single factor, and since a simplified open tank evaporimeter devised in Canada appears to provide a thoroughly practical means of recording this factor in the field, our data have been re-analyzed and charts prepared in which evaporation for a 24-hour period has been substituted for relative humidity. These charts have a higher degree of accuracy than those which involve relative humidity, and, permitting readings at 5 P.M., will perhaps be more convenient for field men than the 2 P.M. relative humidity charts. The fuel moisture charts are to be used in conjunction with forecasts of fire weather by the Weather Bureau to guide fire control organizations in planning their work.

It is planned to get out a report comparing fire-weather and fuel moisture conditions at the four stations where this study was conducted.

## Forest Pathology

The principal activity in forest pathology during the past year has been in the study of Nectria diseases of hardwoods. The need for this work was brought strongly to the front when the stand improvement program of the C.C.C. got under way in 1933. Nectria cankers occur widely distributed on a large number of species. Pathologists devoted considerable time instructing C.C.C. camp superintendents and cultural foremen to recognize this disease and others which should be taken into account in stand improvement work.

Plots for the study of Nectria have been established in Connecticut, Vermont, and New Hampshire. These are aimed at testing the effect of practical field treatments in reducing the source of infection. It appears that moisture is an important factor in the production of Nectria fruits. If infected trees cannot be removed, any treatment which increases the dryness of the infected tree may be helpful in reducing fruiting. Thinning will doubtless serve to reduce the likelihood of infection.

Inoculation tests at Black Brook in New Hampshire involve twelve species of trees. It has been found that more than one species of Nectria must be dealt with and that in general, the fungi will attack many tree species. Thus it appears likely that weed species such as moosewood and mountain maple may serve as sources of infection for more valuable species.

The Nectrias considered in the preceding paragraphs are distinct from the species which has been attacking beech in Maine in conjunction with the felted beech scale insect. Although this Nectria appears to be a weak parasite generally attacking the bark where the scale insects have previously worked, it has been found in New Hampshire and Vermont far beyond the known distribution of the insect.

A stem canker disease of Norway pine (P. resinosa) thus far found only in southern Connecticut has been identified as Tympanis pinastri Tul. This fungus causes cankers at the nodes through which secondary wood destroying fungi enter to weaken the stem at the point of infection. A leaf cast caused by Lophodermium pinastri has also been causing considerable damage to Norway pine in nursery seed beds and transplant beds. Recommendations for control of this disease have been given in Technical Note 18.

Stereum sanguinolentum has been found to cause serious infection in large pruning wounds on young white pine. The serious aspects of this disease in relation to cultural work in young pine stands is called to public attention in Technical Note 19.

Work on the heart rots of balsam fir has been continued and a report is to be prepared during the coming year. This will have a direct bearing on our interest in managing spruce and fir stands under short cutting cycles as indicated in a previous section.

## Forest Entomology

A survey of the distribution of the balsam woolly aphid and establishment of plots for the study of its work was the major activity during 1934. The balsam woolly aphid is now known to have been present throughout New England for many years. During the past two years it has been accompanied by widespread death of the balsam fir trees and continued study will be required to determine the ecological factors responsible for the present situation.

The European spruce sawfly which has been assuming menacing proportions in the Maritime Provinces of Canada, and which has been collected at widely scattered points in New England, deserves mention as a pest whose distribution and control should be studied now.

## Forest Biology

### Wild Life and Forest Management

Work of the Biological Survey on forestry problems during 1934 was largely confined to development of the experimental tract on the Pillsbury State Forest in New Hampshire. Considerable improvement

work has been done by C.C.C. workers and a type map of the entire area has been prepared. Systematic observations of the wild life population of the forest are under way. A portion of the forest is being developed especially for the production of grouse. Experiments in the planting and stimulation of species producing food for grouse and studies of covert conditions are under way.

From work of the past year it appears that the grouse population in central New Hampshire is limited primarily by predators rather than by food supply. The studies indicate that one third of the birds are killed during the winter by fox and bob-cats, and that half of the nests made each spring are lost.

## PROJECT SUMMARY

Although the Program of the Northeastern Station will include 24 projects during the fiscal year 1936, only half of this number are classified as major projects and these will occupy most of the time of the staff. The 24 projects are divided between the four co-operating bureaus as follows:

| Bureau | Major Projects | Minor Projects | Total |
|---|---|---|---|
| Forest Service | 7 | 6 | 13 |
| Plant Industry | 2 | 5 | 7 |
| Entomology and Plant Quarantine | 2 | 1 | 3 |
| Biological Survey | 1 | 0 | 1 |
| Total | 12 | 12 | 24 |

The following is a list of the projects classified as to lines of work and with major projects indicated by an asterisk:

### Economics

* Production Costs-Lumber and Pulpwood — E-1
* Cooperative Forest Management and Utilization — E-2

### Botany

Phenological Observations of Forest Vegetation — B-1

### Forestation

* Forest Planting — F-1

### Management

* Management of Spruce Types — M-1
Management of Central Hardwoods — M-2
Growth, Development of Northern Pines and Hemlocks — M-3

### Mensuration

Development of Universal Taper and Volume Tables — ME-1
Growth and Yield of Spruce and Balsam Fir — ME-2
* Growth of Northern Hardwoods — ME-3

### Protection from Fire

Fire Attack — Pf-1
* Fire Behavior — Pf-2
* Ecological Effects of Forest Fires — Pf-3

### Pathology

Chestnut Blight — Pd-1
White Pine Blister Rust — Pd-2
Shade and Ornamental Tree Diseases — Pd-3

| | |
|---|---|
| Miscellaneous Forest Tree Diseases | Pd-6 |
| * Rots in Balsam Fir Pulpwood Timber | Pd-7 |
| Heart Rots of Northern Hardwoods | Pd-8 |
| * Nectria Diseases of Hardwoods (E.C.W.) | Pd-9 |

Entomology

| | |
|---|---|
| * Control of the White Pine Weevil | Pi-4 |
| Miscellaneous Forest and Shade Tree Insects | Pi-7 |
| * Balsam Woolly Aphid Investigation | Pi-8 |

Biology

* The Interrelation of Wild Life and Forest Management

## SUMMARY OF PERMANENT SAMPLE PLOTS

The number of permanent sample plots now being maintained by the Forest Service in the Northeast is 712, involving a total area of 500 acres. In addition to these forest management plots, numerous other plots are being maintained in this region by the other cooperating bureaus. The Forest Service plots are distributed among the states as follows:

| State | Number of Plots | Total Area |
|---|---|---|
| Maine | 76 | 55.03 |
| New Hampshire | 212 | 168.90 |
| Vermont | 66 | 17.92 |
| Massachusetts | 50 | 35.96 |
| Connecticut | 61 | 16.03 |
| New York | 247 | 206.13 |
| Total | 712 | 499.97 |

## FINANCES

During the fiscal year ending June 30, 1935, regular appropriations, all for forest management, amounted to $57,734.00, but emergency funds brought the total expenditures up to $68,938.00. For the fiscal year ending June 30, 1936, the following allotments have been made available as of August 1, 1935:

| | | |
|---|---|---|
| Regular Funds | | |
| Forest Management | $38,650.00 | |
| Forest Insurance | 12,000.00 | |
| Forest Economics | 18,000.00 | |
| | | 68,650.00 |
| Emergency Relief Administration | | 31,291.00 |
| Emergency Conservation Work (To September 30, 1935 only) | | 3,690.00 |
| Total | | $103,631.00 |

Expenditures by major projects during fiscal year 1935 are compared to the tentative budget for 1936 in the following tabulation:

| | Expenditures F.Y. 1935 | Budget F.Y. 1936 |
|---|---|---|
| F-1 Forest Planting | $14,697.00 | $13,600.00 |
| M-1 Management of Spruce Types | 12,384.00 | 15,600.00 |
| ME-3 Growth and Management, Northern Hardwoods | 13,936.00 | 17,700.00 |
| Pf-3 Fire Damage | 6,730.00 | 7,500.00 |
| E-1 Production Costs | 4,721.00 | 8,000.00 |
| E-2 Cooperative Forest Management | - | 18,000.00 |
| Forest Insurance | - | 12,000.00 |
| M-2 Management of Central Hardwoods ) | | 3,340.00 |
| M-3 Management of Pine and Hemlock ) | 3,683.00 | 5,600.00 |
| Other Minor Projects ) | | 2,291.00 |
| Hale Report | 3,158.00 | - |
| Improvements | 9,629.00 | - |
| | $68,938.00 | $103,631.00 |

## PUBLICATIONS


Behre, C. E. and Reineke, L. H. 1934. A portable gasoline-driven saw for felling and bucking. Journ. Forestry, 32:7, 749-751, 1 figure, 1 table.

_____ and Curran, C. E. 1935. National pulp and paper requirements in relation to forest conservation. Rept. Senate Res. 205, 73rd Congress. Typed manuscript, 130 pages, 15 tables, 11 figures.

Jensen, V. S. 1934. Reproduction following fuelwood cutting operations on the Bartlett Experimental Forest. 7 typed pages, 3 tables.

_____ 1935. Suggestions for weeding in Northern hardwoods. Northeastern Forest Experiment Station, Occasional Paper 3. Mimeographed, 6 pages, 5 tables, 2 figures.

MacAloney, H. J. and Hosley, N. W. 1934. Experiments in simplified control of mound-building ants in the forest. Jour. Forestry, 32:9, 1003-1006.

_____ 1935. Prevention of damage to round-edged white pine lumber by wood-boring insects. Northeastern Forest Experiment Station, Technical Note 21. 2 mimeographed pages.

_____ 1935. The balsam woolly aphid in the Northeast. Jour. Forestry, 33:5, 481-484.

Morey, H. F. 1935. A success index for young forest plantations. Northeastern Forest Experiment Station, Technical Note 16. 2 mimeographed pages, 1 chart.

_____ and Stickel, P. W. 1935. Numbering trees on permanent sample plots with rubber stamps and paint. Jour. Forestry, 33:4, 422-425.

Reineke, L. H. 1935. Discussion of Demeritt and McIntyre's method of constructing tree volume tables. (Jour. Agr. Res. 44 (6): 529-539, 1932). Jour. Forestry, 33:4, 412-418, 3 figures.

_____ 1935. A movable, constant-orientation, lookout map-board. Jour. Forestry, 33:2, 133-136. 2 figures.

Spaulding, Perley. 1935. Lophodermium pinastri causing leafcast of Norway pine in nurseries. Northeastern Forest Experiment Station, Technical Note 18. 2 mimeographed pages.

_____, MacAloney, H. J. and Cline, A. C. 1935. Stereum sanguinolentum: A dangerous fungus in pruning wounds on Northern White pine. Northeastern Forest Experiment Station, Technical Note 19. 2 mimeographed pages.

_____ and Hansbrough, J. R. 1935. The dying of beech in 1934. Northeastern Forest Experiment Station, Technical Note 20. 2 mimeographed pages.

Stewart, G. R. 1935. Criteria of fertility levels as a guide to planting old fields. Northeastern Forest Experiment Station, Technical Note 17. 2 mimeographed pages.

Stickel, P. W. 1934. Forest fire damage studies in the Northeast: I. Bark beetles and fir damaged hardwoods. Jour. Forestry, 32: 7, 701-703.

Westveld, M. 1935. Type definitions based on statistics of stand composition. Northeastern Forest Experiment Station, Technical Note 15. 1 mimeographed page.

The following manuscripts are to be published or completed for publication during the fiscal year 1935:

Behre, C. E. Statistical studies of factors involved in the application of form class volume tables. Estimated 78 typed pages, 16 tables, 10 figures. For Journal of Agricultural Research.

MacAloney, H. J. and Cline, A. C. Progress Report on the reclamation of severely weeviled white pine plantations. To be published in Journal of Forestry. 8 pages, 1 photograph.

Stickel, P. W. Translation of "Studien uber Naturliche Humusformen," by P. E. Muller. To be ready late in 1935. Estimated 300 typed pages.

_____ Forest fire hazard in the Northeast: Its measurement and relationship to weather and forest conditions. To be submitted as Technical Bulletin of the Department. Estimated 75 typed pages, 10 figures, 10 tables.

Patents Granted

Reineke, L. H. U. S. Letters Patent Number 1,978,476, covering movable, constant-orientation mapboard. November 1934.

## NORTHEASTERN FOREST EXPERIMENT STATION

### Personnel

Permanent

Forest Service

| | |
|---|---|
| C. Edward Behre | Director |
| Guy R. Stewart | Senior Forest Ecologist |
| M. Westveld | Silviculturist |
| Victor S. Jensen | Associate Silviculturist |
| Lester H. Reineke | Associate Silviculturist |
| Paul W. Stickel | Associate Silviculturist |
| Harold F. Morey | Assistant Silviculturist |
| Mary E. Turrell | Senior Clerk |
| Julia J. Braun | Assistant Clerk |
| Esther S. Moos | Assistant Clerk |
| Mary C. Weldon | Assistant Clerk |
| Catherine A. Heaphy | Assistant Clerk |
| Alice K. Swain | Assistant Clerk |

Bureau of Plant Industry

| | |
|---|---|
| Perley Spaulding | Senior Pathologist |
| J. R. Hansbrough | Assistant Pathologist |

Bureau of Entomology

| | |
|---|---|
| H. J. MacAloney | Assistant Entomologist |

Bureau of Biological Survey

| | |
|---|---|
| J. Paul Miller | Junior Biologist |

Temporary

| | | |
|---|---|---|
| T. T. Ayers | F. E. Cunningham | Jay Munns |
| W. B. Barrows | Harold Eno | L. P. Plumley |
| K. Belotelkin | T. J. Grant | E. B. Putney |
| Dana Bissell | N. R. Hofert | N. E. Rouillier |
| M. J. Bock | G. S. Hyde | W. K. Starr |

| | | |
|---|---|---|
| W. E. Brown | S. N. Koulichkov | H. B. Washburn |
| T. W. Childs | M. L. Lohman | Alice J. Watson |
| C. P. Cronk | H. A. McBride, Jr. | |

Collaborators

| | |
|---|---|
| H. B. Peirson | Maine Forest Service |
| J. Harry Rich | Massachusetts State College |

## NORTHEASTERN FOREST RESEARCH COUNCIL

Appointed by the Secretary of Agriculture to serve in an advisory capacity to the Northeastern Forest Experiment Station and to coordinate and stimulate forest research by all agencies in the Northeast.

### Maine

| | |
|---|---|
| G. T. Carlisle, Jr. | Consulting Forester |
| N. L. Violette | State Forest Commissioner |
| S. B. Copeland | Vice President, Eastern Manufacturing Company |

### New Hampshire

| | |
|---|---|
| W. R. Brown | President, New Hampshire Timberland Owners Association |
| J. H. Foster | State Forester |
| J. C. Kendall | Director, New Hampshire Experiment Station and Extension Service |
| L. F. Whittemore | General Agent, Boston and Maine Railroad |

### Vermont

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| P. H. Merrill | Commissioner of Forestry |
| B. S. Ward | President, Ward Lumber Co. |

### Massachusetts

| | |
|---|---|
| H. P. Baker | President, Massachusetts State College |
| W. A. L. Bazeley | Land Owner |
| E. H. Thomson | President, Federal Land Bank |
| S. A. York | Commissioner of Conservation |

### Connecticut

| | |
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| H. S. Graves | Dean, Yale School of Forestry |
| A. F. Hawes | State Forester |
| W. L. Slate | Director, Connecticut Agricultural Experiment Station |

New York

| | |
|---|---|
| R. S. Hosmer | Head, Department of Forestry, Cornell University |
| J. J. Farrell | President, Farrell Lumber Company |
| W. G. Howard | Director, Lands and Forests Conservation Department |
| R. S. Kellogg | Secretary, News Print Service Bureau |
| G. N. Ostrander | Manager, Woodlands Department Finch, Pruyn and Company |
| G. W. Sisson, Jr. | President, Racquette River Paper Company. |

Corrected page.

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## Rhode Island

| | |
|---|---|
| H. R. Lewis | Agricultural Consultant |

New York

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| G. W. Sisson, Jr. | President, Racquette River Paper Company |
| S. N. Spring | Dean, New York State College of Forestry, Syracuse University. |